4-22-2020

The Effects of Bisphenol A on Plant A

Michelle Storey
Fort Hays State University, mdstorey@mail.fhsu.edu

Effects of Bisphenol A Exposure On Plant Growth

Michelle Storey
Fort Hays State University, Geoscience

FORT HAYS STATE UNIVERSITY
Forward thinking. World ready.

Introduction

Bisphenol A (BPA) is a ubiquitous raw material used in the production of many everyday things such as food packaging and baby bottles. While there have been many studies about the effect that this can have on water and animals, there are not as many focusing on how BPA exposure directly affects plant growth and development. In some of these studies, scientists exposed the plants' to high doses of BPA, such as 50 mg/L (Ferrara, Loffredo, & Senesi, 2005), while in the others they used smaller doses, the highest being 12 mg/L (Xia, Wang, Nie, Zhou, & Huang, 2016) and (Li, Wang, Wang, Yang, Zhou, & Huang, 2017). The results of these studies showed that using four exposure levels that are close together in size is better than using two levels with a high deviation.

Methodology

Ferrara, G., Loffredo, E., & Senesi, N. (2006)

- Placed broad bean, tomato, durum wheat, and lettuce seeds into petri dishes with 8 mg/L of 10 mg/L or 50 mg/L BPA solution and grew them to seedling stage inside a Phytotron growth chamber.
- Placed uniform seedlings of each species and treatment into jars filled with various amounts of test solution and again grew them in the chamber.
- Observed, separated, measured, dried, and weighed the plants' roots and shoot morphologies at 21 days of growth.

Li, X., Wang, L., Wang, S., Yang, Q., Zhou, Q., & Huang, X. (2017)

- Grew soybean seeds to four weeks, and then transplanted them into BPA solutions of four concentrations (0 mg/L, 1.5 mg/L, 6.0 mg/L, and 12.0 mg/L).
- Grew the seeds in the corresponding solutions for seven days before transplanting them into a half-strength Hoagland's solution without BPA for the next seven days.
- Measured and weighed the root morphologies.
- The BPA exposure and withdrawal tests were run when the soybean plants reached the flowering and podding stage, and again at the pod-filling stage.
- Weighed roots fresh and dry when testing was over.

Xia, B., Wang, L., Nie, L., Zhou, Q., & Huang, X. (2016)

- Placed soybean seedlings into plastic pots filled with BPA solutions of 1.5 mg/L, 6.0 mg/L, and 12.0 mg/L where they were cultured for seven days.
- Collected roots after seven days for measurement and test indices.
- Repeated this procedure in the same way through the flowering and podding stage, and the seed-filling stage.
- Determined changes in root activity.

Stats

Every article replicated their tests 5 times. All data was displayed in the mean value plus or minus standard deviation..

Results

According to Li, X., Wang, L., Wang, S.,Yang, Q., Zhou, Q., & Huang, X. (2017), exposure to BPA above 1.5 mg/L increased fresh and dry weights, length, and volume of plant roots, and a decrease in these root properties at exposure levels of 6.0 mg/L and above.

- After the withdrawal of 1.5 mg/L BPA, the root growth and length increased (Li, Wang, Wang, Yang, Zhou, & Huang, 2017). After the withdrawal of 6.0 mg/L, and 12.0 mg/L root properties continued decreasing.
- Ferrara G., Loffredo E., and Senesi N., (2006), found that BPA exposure, especially at a higher dosage caused root browning and the formation of "a jelly-like substance" (Ferrara, Loffredo, & Senesi 2005).
- With exception to the broad bean, the fresh and dry weights of root and shoot samples were significantly reduced due to BPA exposure, especially that of 50 mg/L BPA.

Xia, B., Wang, L., Nie, L., Zhou, Q., and Huang, X. (2016), found that with increased BPA concentration there is a decrease in root activity, as figure 1 below shows.

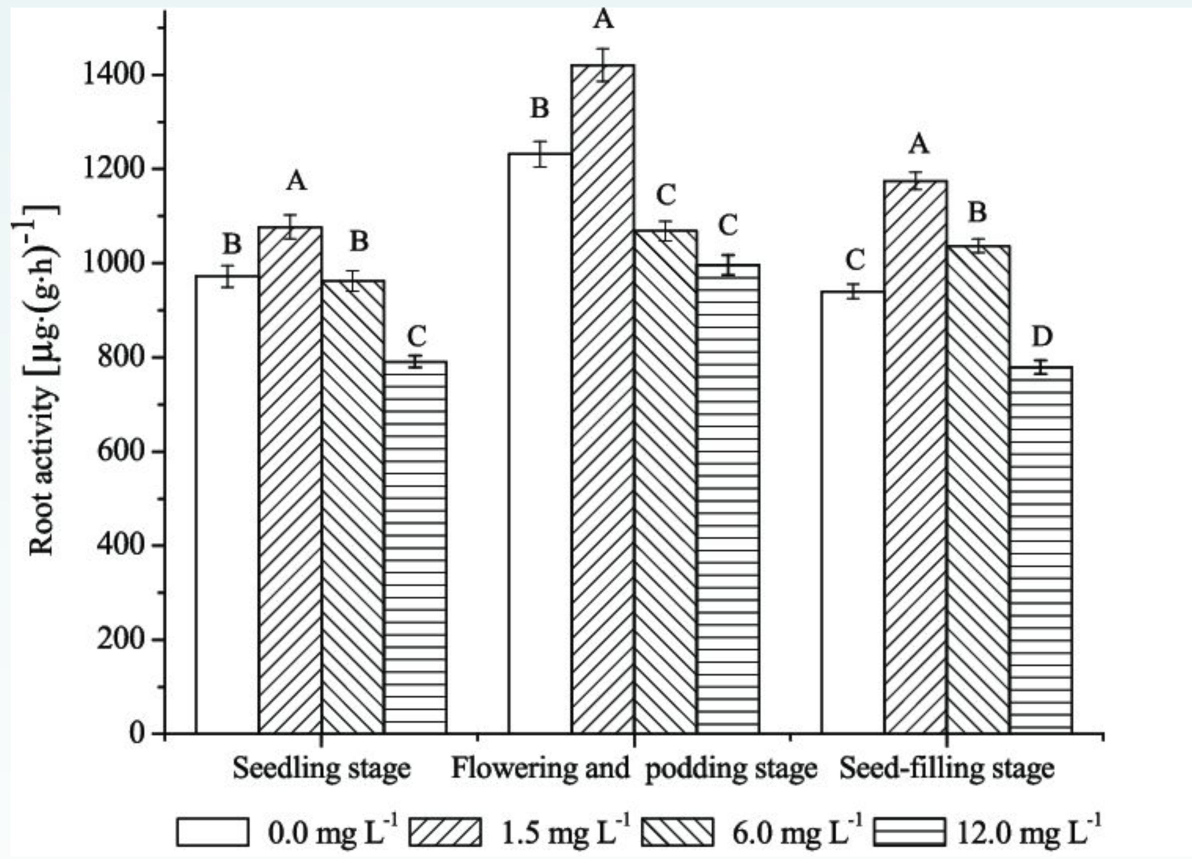

Figure 1 Effects of BPA o plant growth at different stages. Significant differences of po 0.05 are denoted by letters at different growth stages. (Xia, Wang, Nie, Zhou, & Huang, 2016).

Discussion

Each of the studies found increased concentration of BPA exposure to the plant roots, correlates with a decrease in root growth and weight. We can postulate that high exposure to BPA causes plants to have difficulties growing. To place regulations on volumes of BPA output into the environment, we need to determine the point at which the concentration of BPA becomes too high and begins to hurt the plant. Xia, Wang, Nie, Zhou, and Huang (2016), and Li, Wang, Wang, Yang, Zhou, and Huang, (2017), have the most effective way of answering this question, because there were four small concentration levels used (0 mg/L, 1.5 mg/L, 6.0 mg/L, and 12.0 mg/L BPA), rather than, when Ferrara, Loffredo, and Senesi, (2006), only used two concentrations, with a high deviation (10 mg/L and 50 mg/L). The smaller steps help us to more clearly see at what point the BPA started negatively affecting the plants' growth.

An increase in fresh and dry weights, length, and volume of plant roots (Li, Wang, Wang, Yang, Zhou, & Huang, 2017), as well as, root activity at an exposure level of 1.5 mg/L BPA (Xia, Wang, Nie, Zhou, & Huang, 2016) shows that this is not a dangerous concentration, and may in fact prove beneficial to the plants' growth. In correlation with this, the decrease in all of these at exposure levels of 6.0 mg/L and 12.0 mg/L BPA shows that those exposure levels would be unsafe in the natural environment, as plant growth has an affect on many other aspects of the natural world.

Conclusion

- Bisphenol A, an important industrial raw material, is "able to produce evident and differentiated morphological and physiological effects on the growth of seedlings…" (Ferrera, Loffredo, & Senesi 2005).
- 1.5mg/L BPA can actually cause an increase in many root properties in plants (Li, Wang, Wang, Yang, Zhou, & Huang, 2017)
- BPA levels from 6.0mg/L to 50mg/L have the opposite effect on root properties, causing many of the samples to express a decrease in root activity, length, volume, and fresh and dry weight (Li, Wang, Wang, Yang, Zhou, & Huang 2017).
- Using multiple concentration levels is the most effective way to determine the turning point of BPA exposure from beneficial to detrimental.

References

Xia, B., Wang, L., Nie, L., Zhou, Q., & Huang, X. (2016). "A pathway of bisphenol A Affecting mineral element contents in plant roots at different growth stages." *Ecotoxicology and Environmental Safety*, 135, 115-122. www.sciencedirect.com/science/article/pii/S0147651316303815?via%3Dihub

Li, X., Wang, L., Wang, S.,Yang, Q., Zhou, Q., & Huang, X. (2017). "A Preliminary Analysis of the Effects of Bisphenol A on the Plant Root Growth via Changes in Endogenous Plant Hormones." *Ecotoxicology and Environmental Safety*, 150, 152-158. www.sciencedirect.com/science/article/pii/S0147651317308667?via%3Dihub

Ferrara, G., Loffredo, E., & Senesi, N. (2006). Phytotoxic, clastogenic and bioaccumulation effects of the environmental endocrine disruptor bisphenol A in various crops grown hydroponically. *Planta*. 223. 910-6. 10.1007/s00425-005-0147-2